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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
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| 09/846,536 | 05/02/2001 | Wen-Ting Chu | TS1999-646B | 4121 |

7590 12/03/2001
George O. Saile
20 McIntosh Drive
Poughkeepsie, NY 12603

EXAMINER

NADAV, ORI

| ART UNIT | PAPER NUMBER |
|----------|--------------|
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2811

DATE MAILED: 12/03/2001

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.
09/846,536

Applicant(s)
Chu et al.

Examiner
ORI NADAV

Art Unit
2811



-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on Jul 18, 2001.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 20-24 is/are pending in the application.
- 4a) Of the above, claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 20-24 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claims _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are objected to by the Examiner.
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

- 13) ☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).
- a) ☐ All b) ☐ Some* c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- *See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

- 15) ☒ Notice of References Cited (PTO-892) 18) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 16) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 19) ☐ Notice of Informal Patent Application (PTO-152)
- 17) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s). 3 20) ☐ Other:

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DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claims 20-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nagashima (5,312,773) or Harada et al. (5,341,026).

Nagashima teaches in figure 7 an upper level, metal interconnect structure, on a semiconductor substrate, comprising a lower level, metal interconnect structure 32, an insulator layer 34 on the lower level, metal interconnect structure; a via hole in the insulator layer exposing a portion of a top surface of the lower level, metal interconnect structure, a recessed metal plug structure 48, located in a bottom portion of the via hole, with the recessed metal plug structure overlying and contacting the portion of the lower level, metal interconnect structure 32, exposed in the via hole; and the upper level, metal interconnect structure, comprised of a metal structure component (36 and outer part of 50), and of a metal ring component (inner part of 50), with the metal structure component 36 located on a portion of a top surface of the insulator layer, and also (outer part of 50) located on an edge of underlying, the recessed metal plug

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structure, and with the metal ring structure (inner part of 50), attached to the metal structure component, located overlying, and contacting portions of a top surface of the recessed metal plug structure, with the metal ring component comprised of metal spacers on the sides of a top portion of the via hole.

Although Nagashima does not explicitly state that a metal structure component located on a portion of a top surface of the insulator layer, and also located on an edge of underlying recessed metal plug structure, the broad recitation of the claim does not require the metal structure component to comprise one integral element. Therefore, Nagashima teaches a metal structure component 36 located on a portion of a top surface of the insulator layer, wherein an outer part of 50 is located on an edge of the underlying recessed metal plug structure. Thus, the claimed structure is considered to be at least obvious over Nagashima's structure.

Harada et al. teach in figure 10 an upper level, metal interconnect structure, on a semiconductor substrate 1, comprising a lower level, metal aluminum interconnect structure 4, an insulator layer 5 on the lower level, metal interconnect structure; a via hole in the insulator layer exposing a portion of a top surface of the lower level, metal interconnect structure, a recessed tungsten metal plug structure 206, located in a bottom portion of the via hole, with the recessed metal plug structure overlying and contacting the portion of the lower level, metal interconnect structure 4, exposed in the

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via hole; and the upper level, metal aluminum interconnect structure, comprised of a metal structure component, and of a metal ring component, with the metal structure component 103 located on a portion of a top surface of the insulator layer, and also located on an edge of underlying, the recessed metal plug structure, and with the metal ring structure, attached to the metal structure component, located overlying, and contacting portions of a top surface of the recessed metal plug structure, with the metal ring component comprised of metal spacers on the sides of a top portion of the via hole. Although Harada et al. do not explicitly state that layer 206 is a recessed plug, layer 206 can very well be characterized as a recessed plug, because layer 206 is formed in a bottom portion of the via hole, and overlying and contacting the portion of the lower interconnect level. Therefore, Harada et al. teach a recessed plug. Thus, the claimed structure is considered to be at least obvious over Harada et al.'s structure.

Regarding claim 21, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to use a lower level metal interconnect structure, with an underlying and overlying titanium nitride layer in Nagashima and Harada et al.'s device in order to provide conventional barrier around the lower level metal aluminum interconnect structure, of which official notice is taken.

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Regarding claims 21-24, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to use a lower level metal aluminum interconnect structure at a thickness between about 2000 to 20000 Angstroms, with an underlying titanium nitride layer, at a thickness between about 100 to 1500 Angstroms, and an overlying titanium nitride layer, at a thickness between about 100 to 1500 Angstroms, wherein the via hole is comprised with a diameter between about 0.10 to 1.0 μm , and wherein the recessed metal plug structure, is comprised of tungsten, with the height of between about 3000 to 20000 Angstroms, and metal aluminum ring structure in Nagashima and Harada et al., since it is a matter of design choice within the skills of an artisan, subject to routine experimentation and optimization.

3. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. References C-D are cited as being related to interconnect structures.

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Papers related to this application may be submitted to Technology center (TC) 2800 by facsimile transmission. Papers should be faxed to TC 2800 via the TC 2800 Fax center located in Crystal Plaza 4, room 4-C23. The faxing of such papers must conform with the notice published in the Official Gazette, 1096 OG 30 (November 15, 1989). The Group 2811 Fax Center number is (703) 308-7722 and 308-7724. The Group 2811 Fax Center is to be used only for papers related to Group 2811 applications.

Any inquiry concerning this communication or any earlier communication from the Examiner should be directed to *Examiner Nadav* whose telephone number is (703) 308-8138. The Examiner is in the Office generally between the hours of 7 AM to 3 PM (Eastern Standard Time) Monday through Friday. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tom Thomas, can be reached at (703) 308-2772.

Any inquiry of a general nature or relating to the status of this application should be directed to the **Technology Center Receptionists** whose telephone number is 308-0956

Ori Nadav

November 16, 2001

Steven Loke
Primary Examiner

